Chapter 7
Eco-cities in China: Pearls in the Sea of Degrading Urban Environments?

Tai-Chee Wong

China's current development is ecologically unsustainable, and the damage will not be reversible once higher GDP has been achieved.

Zhenhua XIE, Minister of State Environmental Protection Agency, China (Arup 2007).

Abstract Economic reforms in China from the 1980s have created substantial material wealth and raised consumption to an unprecedented level. With rising affluence and demand for quality living, densely urbanized zones are increasingly being developed into eco-conscious townships or eco-cities. Whilst commercial entrepreneurship may have adopted norms of eco-city construction in selected sites including coastal areas, major cities and their rapidly extended metropolitan zones have encountered major pollution problems, threatening health and quality of life of ordinary residents. Will eco-cities serve as a normatic model for other Chinese cities to follow towards an improved urban environment? Or are they merely nodal points serving more commercial interests catering to the need of rising middle classes? This chapter investigates the hindrance and potential in developing an environmentally sustainable urban system in a country undergoing a late but rapid urbanization backed up by a huge surplus rural population eager to settle down in the cities. This is followed by analysis of public policy measures in energy saving, promotion of renewable energy, public transport, reforestation, recycling of water and other materials. Finally, the role of ecocities is studied in terms of whether they have the potential to lead a new development path towards a more sustainable urban future in China.

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7.1 Introduction

Over the last decade, building ecocities has become a highly fashionable *modus operandi* worldwide. It serves multiple purposes, of which the two most important are to counter the degrading urban environment and, in the process of building it, to create new business opportunities using clean technologies and conservationist measures.

By its most fundamental motivation, at least in theory, an eco-city offers to provide a sustainable lifestyle for both highly interdependent humans and non-human living things. An eco-city aims to provide conditions that enhance the sustainability and productivity of ecosystems, with a broad array of possible life pathways and a capacity to respond to environmental change and undesirable disturbances (see Newman and Jennings 2008: 97 and 102). In other words, such a capacity helps ecosystems to maintain nature's self-regulatory mechanism which could restore the living environment back to operational activities after a disturbance. Accordingly, Newman and Jennings (2008) argue that ecosystems, as long as their resilience and self-renewal ability are not destroyed, should be able to:

> maintain their structure and function under conditions of normal variability. In the face of external or internal disturbance, the structure of the ecosystems may change and functioning may be disrupted, the ecosystem will be able to restore functionality (ibid: 99).

Resilience is defined as:

> the capacity of a system to undergo disturbance and maintain its functions and controls, and may be measured by the magnitude of disturbance the system can tolerate and still persist (Wallington et al. 2005: 4, cited in Newman and Jennings 2008: 99).

Thus, an eco-city has the great potential of being deployed as a technical and pro-environmental instrument in dealing with ecological problems. More specifically, as it tackles urban-sourced environmental issues, its most useful target would be countries currently undergoing high rates of urbanization with haphazard environmental and pollution problems, a typical of which is China under urban reforms.

China is a large country with 1.3 billion people. With a fast growing economic influence and urban population, urban-industrial development over the last 30 years has produced substantial ecological impacts. Adverse effects are expected to spread from population centres to less developed lands in the near future if the deteriorating urban physical environmental conditions are not sufficiently and readily improved. A heavy price has been paid for great emphasis on GDP growth with an outcome of environmental degradation and health hazards. Reportedly in the mid-2000s, 70% of China's lakes and rivers were polluted (Cook 2007: 30).

As a consequence, examining Chinese cities as ecosystems is to look at how the whole urban habitat reacts to the pressing problems, to the ways energy and materials flow and the measures wastes are treated. Realizing the seriousness of the environmental degradation, eco-city development has been one of China's responses to the environmental crisis, with a focus centred at its high density city regions most vulnerable to this threat. Along China's coastal regions and the major river valleys, cities have grown much larger; some growing into forms of urban belts. As material

consumption continues to increase rapidly, environmental problems are anticipated to intensify.

This chapter examines China's attempt to remedy the adverse consequences of urban development disassociated largely from the logics of the natural ecological system. In tackling this environmental crisis, eco-city development is concomitantly perceived to be an opportunity for business undertakings where foreign investment and expertise are welcome. The Tianjin Eco-city Joint-Venture between China and Singapore is exemplary of this commercial undertaking. This study will analyze the involvement of Singapore's government-linked companies in constructing an eco-city prototype in the coastal city of Tianjin. First, however, it is crucial to examine why it is an urgency that China needs to manage head-on its run-away urban pollution and environmental degradation.

7.2 Degrading Environments and Demographic Growth of Chinese Cities

Environmental degradation could be traced back to over the last 3,000 years of development history in China's relatively fragile physical environment in feeding a large agriculture-based population. Over this period, its intensive agricultural practice is best mapped by a Han Chinese expansion covering a vast fertile and not so fertile arable lands. This vast movement of population expansion over 20 dynasties went across the central plains in the north, Yangtze Valley in the middle, coastal zones in the east and south, steppes, grasslands in the far north and north-west, and mountains and jungles in the south-west and the west. According to Mark Elvin (2004: 5), this relatively long period of landscape transformation to suit the Chinese permanent and high-density agricultural habitat was characterized by:

> Cutting down most of the trees for clearance, buildings, and fuel, an ever-intensifying garden type of farming and arboriculture, water-control systems both large and small, commercialization, and cities and villages located as near the water's edge as possible.

Deforestation, as in other early civilizations, was necessary to accommodate an expanding population and their activities. Population size was perceived as an important source of collective and individual wealth, and removing mountains was seen as a highly regarded achievement in overcoming barriers imposed by nature. The resulting inherited degraded natural landscape of China which existed at the time of the 1949 Revolution forced new generations to face multiple challenges.

In Mao's China from the early 1950s to the late 1970s, the streets of major Chinese cities were a "world of bicycles". Immediately outside the city built-up area, farmlands dominated the rural landscape and retained many of their pre-1949 features. Anti-urban Marxist doctrine had restricted city size in favour of the core economic sectors of agricultural production and heavy industries. Mobility of peasants to cities was tightly controlled by the *hukou* system, characterized by its rigidity in the transfer of residence permit from a rural to an urban place. From the 1980s,

a sharp turn in urbanization trends occurred when Deng Xiaoping championed reforms to transform the economic system in general and, as a result, the urban landscape in particular.

Post-Mao China since the 1980s has not only witnessed urban proliferation and demographic expansion but also a new phase of population relocation from the inner cities to the newly built high-rise apartments in the suburbs. The city centre itself has seen redevelopment to accommodate younger and better qualified couples. Bicycles, though still in large numbers, have given way to city trains and buses serving the large number of commuters. In parallel to this change, highways and other complimentary infrastructure have provided easier links to facilitate the rising mobility of the urban working population. Rising affluence and the concentration of middle classes in major cities have equally produced an increasingly large number of car-dependent commuters, rising consumption of consumer and non-consumer goods have generated high rates of pollutants. In an international assessment of city environment in 2004, China was ranked 100th of 118 countries taking part in the exercise as most polluted. Among the 20 worst polluted cities in the world, China owned 16 of them (Zhai 2009). A key source of pollution has come from the sharp rise in vehicles. From 1980 to 2008, the total number of vehicles rose 28.6 times against a national population growth of merely 34.5% (National Bureau of Statistics of China 2009).

7.2.1 Situation of the Degrading Urban Environment

China's present state of degraded urban environment should be attributed to a fast changing socialist state from Mao's frugal, largely self-reliant and lowly industrialized social organization to an urban-industrial driven economic base supported by a highly successful export-led manufacturing industry. The new scenario is characterized by a changing lifestyle towards an urban-based consumerism and a general lack of practical experience in dealing with complex sources of industrial and transport-related pollution.

Rates of urbanization in the post-1980s till today might be interpreted as a differentiated Chinese "great leap forward" in both physical and demographic scales. In 1980, only 19.4% of the nearly one billion Chinese population was classified as urban against a nearly 800 million peasants (see Table 7.1). By 2008, out of the total 1.328 billion people, the urban population had gone up to 45.7%. If the unregistered floating population of peasant origin who work as migrant workers in the cities are added, the urban proportion would have been even higher to over 50%.

Origins of the urban pollution sources were not attributable to migrant workers but to the expanding industries, and the economic activities and changing lifestyle made possible by rising affluence and consumption levels. Also, fast pace of industrialization and modernization has largely not been met with modern pollution control measures. Large numbers of low- to medium-cost industries were built in the fringe of major cities supported by China's ample supply of low-cost labour

Table 7.1 Urban and rural population change in China during 1980–2008

Year	Total population (1,000)	Urban population (1,000)	Proportion (%)	Rural population (1,000)	Proportion (%)
1980	987,050	191,400	19.4	795,650	80.6
1985	1,058,510	250,940	23.7	807,570	76.3
1990	1,143,330	301,950	26.4	841,380	73.6
1995	1,211,210	351,740	29.0	859,470	71.0
2000	1,267,430	459,060	36.2	808,370	63.8
2005	1,307,560	562,120	43.0	745,440	57.0
2008	1,328,020	606,670	45.7	721,350	54.3

Note: Data for the period 1990–2000 were adjusted using the 2000 National Population census, and the 2008 figure was estimated using the annual national sample surveys on population change
Source: National Bureau of Statistics of China (2009, table 3–1)

available from the rural sector. As Table 7.2 indicates, during the period 1980–2008 growth of civil vehicles was significant, rising from 1.78 million vehicles in 1980 to 16.1 million in 2000, and almost 51 million in 2008. As one can observe from the table, passenger cars saw an out-of-proportion rise from 2000 to 2008, increasing by 4.5 times in a short span of 8 years. Obviously, the rise is mostly in the major cities such as Beijing, Tianjin, Shanghai and Chongqing where the emerging middle and upper middle classes are highly concentrated. Recent trend in vehicular rise in Beijing shows a sharp climb of 31.2% from 2006 to 2008 alone. It is indeed in the major cities where air pollutants are most serious.

Table 7.3 shows that, of the 15 cities studied in terms of particulate matters emission in 2008, their air quality all exceeded the World Health Organization's standard,

Table 7.2 Growth of civil vehicles in China, 1980–2008

Year/city	Total number of vehicles (1,000)	Passenger vehicles (1,000)	Trucks (1,000)	Other vehicles (1,000)
1980	1,782.9	350.8	1,299.0	133.1
1985	3,211.2	794.5	2,232.0	184.7
1990	5,513.6	1,621.9	3,684.8	206.9
1995	10,400.0	4,179.0	5,854.3	366.7
2000	16,089.1	8,537.3	7,163.2	388.6
2005	31,596.6	21,324.6	9,555.6	716.6
2008	50,996.1	38,389.2	11,260.7	1,346.2
Beijing	3,136.8	2,910.2	181.3	45.3
Tianjin	1,084.7	917.1	146.8	20.8
Shanghai	1,321.2	1,107.3	213.9	–
Chongqing	736.4	466.6	254.7	15.1

Note: Figures of Beijing, Tianjin, Shanghai and Chongqing are for 2008
Source: Adjusted from National Bureau of Statistics of China (2009, table 15–26)

Table 7.3 Ambient air quality in major Chinese cities, 2008

City	Particulate matters (PM10)	Sulphur dioxide (SO_2)	Nitrogen dioxide (NO_2)	Days of air quality meeting grade II standards
Beijing	0.123	0.036	0.049	274
Tianjin	0.088	0.061	0.041	332
Taiyuan	0.094	0.073	0.021	303
Shenyang	0.118	0.059	0.037	323
Harbin	0.102	0.043	0.055	308
Shanghai	0.084	0.051	0.056	328
Nanjing	0.098	0.054	0.053	322
Hangzhou	0.110	0.052	0.053	301
Fuzhou	0.071	0.023	0.046	354
Wuhan	0.113	0.051	0.054	294
Guangzhou	0.071	0.046	0.056	345
Chongqing	0.106	0.063	0.043	297
Chengdu	0.111	0.049	0.052	319
Kunming	0.067	0.051	0.039	366
Xi'an	0.113	0.050	0.044	301
WHO Standard[a]	0.020	0.020	0.040	[b]

Source: National Bureau of Statistics of China (2009, tables 11–17, 11–18, 11–19 and 11.24)

Note: All measurements in milligram/cubic metres

[a]World Health Organization 2006. http://libdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_chi.pdf, accessed May 27, 2009

[b]Using the Air Pollution Index (API) classified as Grade II (50–100), these are the number of days a year where air quality is good enough to allow normal outdoor activities

by 4.2 times (Shanghai) to as high as 6.2 times (Beijing). The emission levels of sulphur dioxide and nitrogen dioxide were not as bad as particulate matters but would still have exceeded WHO's standard up to 3.7 times (Taiyuan) (National Bureau of Statistics of China 2009). As to the number of days per year where air quality was good enough for outdoor activities, Beijing had the lowest of 274 days as against Fuzhou, a coastal city, that enjoyed a high 354 days in 2008.

Solid wastes generated in the large cities are on the rise. Highly polluting heavy industries that used to be located in strategic and key centres such as Chongqing and Kunming in the country's southwestern region are known to have discharged cumulatively huge solid wastes. The percentage of industrial waste treated has improved over the years, yet there is still much room for improvement (Table 7.4). Water is a scarce resource for much of China, notably in the north, northwest and far west of China. Rising consumption since the reforms has seen the decline in storage in both surface and ground levels (Table 7.5). Total water consumption from 2002 to 2008 alone increased by 7.5%. However, living consumption of water to meet daily household needs during the same period rose by 17.9% nation-wide. Much of the waste

Table 7.4 Emission and treatment of industrial solid wastes in major Chinese cities, 2008 (in 10,000 tons)

City	Industrial solid wastes generated	Hazardous wastes	Industrial solid wastes treated	Percentage of industrial solid wastes treated
Beijing	1,157	11.53	835	66.4
Tianjin	1,479	14.79	1,471	98.2
Taiyuan	2,532	3.08	1,202	47.4
Shenyang	479	8.09	461	92.3
Harbin	1,150	1.61	860	74.8
Shanghai	2,347	49.28	2,242	95.5
Nanjing	1,383	18.91	1,282	92.4
Hangzhou	585	7.98	557	95.1
Jinan	1,076	8.87	1,028	94.4
Zhengzhou	1,077	0.24	841	78.1
Wuhan	1,094	1.34	1,007	89.6
Guangzhou	662	16.38	606	91.2
Chongqing	2,311	8.08	1,851	79.1
Chengdu	725	0.79	713	98.3
Kunming	1,989	1.29	790	39.7
Lanzhou	372	17.36	291	78.1

Source: National Bureau of Statistics of China (2009, tables 11–30)

water discharge produced health hazards, turning some rivers into stint waterbodies (Wu et al. 1999, Yangcheng Evening News 2008). The acuteness of environmental harmony has been placed on par with social harmony needed for priority treatment and contemplation (Woo 2007).

7.3 Eco-cities as a Solution to Degrading Environment?

In the face of polluting cities, strengthening environmental governance has been prioritized on the Chinese national agenda for action. In retrospect, economic transformations and growing openness with tightened integration with the market-led advanced capitalist economies have inevitably forced China to change its conventional centrally planned economic style practised during the period 1949–1979. China started to see the urgency to change its *laissez-faire* approach of environmental management which was inefficient and ineffective during this period characterized by low levels of industrialization and pollution.

In 1979, the state Environmental Protection Law was promulgated in China, and in 1984, environmental protection was conceived as a fundamental policy to regulate polluting activities (see Mol and Carter 2007). Subsequently, a series of executive regulations, standards and measures were adopted at four-tier levels (national, provincial, municipal and county) in the 1980s and 1990s after serious references to those of developed economies. Indeed, atmospheric pollution levels would have

Table 7.5 Water and atmospheric conditions in China, 2002–2008

Items	2002	2003	2004	2005	2006	2007	2008
Water available (100 million cu. m)							
Surface water resource	27,243.3	26,250.7	23,126.4	26,982.4	24,358.1	24,242.5	26,377.0
Groundwater resource	8,697.2	8,299.3	7,436.3	8,091.1	7,642.9	7,617.2	8,122.0
Per capital water resource (cu. m)	2,207.2	2,131.3	1,856.3	2,151.8	1,932.1	1,916.3	2,071.1
Water consumption (100 million cu. m)							
Total consumption	5,497.3	5,320.4	5,547.8	5,633.0	5,795.0	5,818.7	5,910.0
Living consumption	618.7	630.9	651.2	675.1	693.8	710.4	729.3
Atmosphere (100 million cu. m)							
Industrial waste air emission	175,257	198,906	237,696	268,988	330,992	–	403,866
Fuel burning	103,776	116,447	139,726	155,238	181,636	–	229,535
Sulphur dioxide emission (1000 tons)	19,270	21,590	22,550	25,490	25,890	–	22,864
Soot emission (1000 tons)	10,130	10,490	10,950	11,830	10,890	–	9,016

Note: All measurements in 100 million cubic metres unless indicated otherwise
Source: Adjusted from National Bureau of Statistics of China (2009, tables 11–17, 11–18, 11–19, 11–24)

been even more spectacular had there not been measures to control the emission of greenhouse gases.

Over the last two decades, actions have comprised greater commitments to international environmental treaties, publicity and education efforts to enhance environmental awareness, more efficient resource use, adoption of newer environment-friendly technologies, cleaner products and closing of heavily polluting factories (Mol and Carter 2007: 2).

Indeed, the Chinese government has taken serious initiatives to develop eco-cities at national, provincial and local levels to counter the adverse effects of environmental degradation. At the central State Council level, the State Environmental Production Agency of China (SEPA) issued in 2003 "The Constructing Indices of Eco-county, Ecocity and Eco-province" which became the general national standard of ecological assessment. Because Chinese cities usually cover within their administrative boundary urban built-up, farming and nature areas, massive rural reafforestation is often adopted to return the cities to a more natural state to which municipal governments claim that helps them in their efforts to be an eco-city.

During the past 25 years, 390 national demonstration ecopolis have been appraised and named by the Ministry of Environment including prefecture and county level cities such as Yangzhou, Shaoxin, Panjing, Yancheng, Hangzhou, Xuzhou, Guangzhou, Changsha, Haining, Anji, Changsu, Zhangjiagang, Kunshan, Longgang district of Shenzhen, Rizhao and Dujiangyan. Among the many cities being assessed, 32 have passed "environmental model city" appraisal. Furthmore, 13 provinces initiated eco-province development (Hainan, Jilin, Heilongjiang, Fujian, Zhejiang, Shandong, Anhui, Jiangsu, Hebei, Guangxi, Sichuan, Tianjin and Liaoning). 108 experimental cities/counties towards sustainable development covering 29 provinces of China, had been appraised and named by the Ministry of Science and Technology. Big progress had been made in these case studies while some lessons and challenges also emerged such as institutional barrier, behavioural bottleneck and technical malnutrition (Wang et al. 2004, Wang and Xu 2004, Yip 2008).

Despite successes in some aspects, environmental governance has still much to be desired due to the scale of industrial development across the vast country, difficulties in modernizing old and outdated manufacturing plants for fear of job losses, and the creation of new factories at different technological levels. Added to these are a legacy of an older industrial workforce and a fluid social and political environment in the transitional period in which enforcement is a thorny issue. As a strategy at the national level, creating a model city, for the Chinese leaders, is seen as a more workable option considering its potential of demonstration effects.

Eco-cities represent thus a symbolic hope to solving urban degradation problems. According to Rodney White (2002: 3), an eco-city can be defined as "a city that provides an acceptable standard of living for its human occupants without depleting the ecosystems and biogeochemical cycles on which it depends". In energy consumption, the eco-city concept supports a human habitat that, as far as possible, uses non-fossil fuels, and energy saving means to achieve a low aggregate consumption. As a developing country having a relatively low-technology base in pollution

control, China has attempted to build up its own standards to guide eco-city planning and development. Adjusting "The Constructing Indices of Eco-county, Eco-city and Eco-province" formulated by "The State Environmental Production Agency of China" in 2003, and using a more sophisticated index classification method covering common characteristics and feature indices,[1] Li Shengsheng and his research partners have worked out a set of criteria that have recognized the different problems faced by different cities. For example, the number of days where air quality is equal to or better than the level 2 standard set by the United Nations fit for outdoor activities is set differently between regions. Li and partners have set 330 days as the minimum acceptable standard for south China but 280 days for the drier north China closer to the arid Inner Mongolia producing often thunder storms sweeping southward during winter. Similarly, disposable income levels would determine the consumption pattern and total personal expenses that would have contributed to total wastes in the cities being compared. They have recommended different limits of personal consumption in monetary terms as an indicator for urban environmental control (Li et al. 2010).

Overall, the low aggregate consumption per capita is translatable into a small and acceptable ecological footprint. As cities are getting larger, and an increasingly large population lives in the cities, actions towards cutting down aggregate consumption have to be concentrated at the local level (the cities). Large cities as nodal points are where consumption of materials and energy is very high on per capita basis. Poor environmental management is bound to lead to a degrading urban environment harmful to different habitats in the urban ecological system including definitely humans. The fundamental concept of eco-cities is to incorporate functions of nature in a miniature manner to serve the interests of human developments. This could be done through "green design" of buildings, infrastructure and integration of nature areas and waterbodies into the urban setting. The resulting lifestyles to be encouraged for citizens to follow would depend essentially on the exploitation of the natural processes (solar radiation, water flows, wind) to achieve desired urban comfort levels, rather than using fossil fuel derived power for heating, lighting and cooling (see Roberts et al. 2009, White 2002).

Taking cities as an ecological system and applying an ecological approach, there is potential that functioning mechanism should fit into a characteristically sustainable urban environment. The development approach is to treat cities ideally as a habitat for animals and plants, and to use as much as possible biological and natural means or resources for the needs of such habitat (Deelstra 1988, Pickett et al. 2001, Mitchell 2004, Hultman 1993, Wheeler and Beatley 2009).

In practice, the conceived approach to achieving eco-city ideals needs to proactively counter industrialist and consumerist lifestyle characterized by, for example, a high intensity of automobile invasion by promoting green energy-based public transit and other environmentally friendly buildings and infrastructure. The aimed outcome by its very nature is to minimize environmental degradation, and to achieve a minimally acceptable quality of life in a sustainable way. This study will focus on eco-cities and their role in transforming the quality of life of residents threatened by a degrading physical environment in a rapidly urbanizing and metropolizing

contemporary world (Tibbetts 2002). Ecocities recently developed in China are taken as a case study.

7.4 Eco-city Development in China

Apparently, eco-city development is a brand-new concept in post-Mao China arising from rapid pace of urban proliferation characterized by serious pollution problems. The perception towards eco-city urbanism has inequitably attracted multiple interests, interpretations as well as enquiries from different social spectrums in China.

Critics such as Zhai Ruiming (2009), commented that eco-city projects had attracted at least 100 Chinese cities to bid for fund allocations, and for some interest groups, their primary objective was to use the concept as a pretext to secure land approval in the face of the tightened land control policies. Using Chinese classical and philosophical interpretation, eco-city development is an approach to bring about an integration of "heaven" and "Earth" with the help of high technology and applied ecological principles to achieve an artificial but harmonious urban living environment. Such harmony is achievable via regulating the cyclic mechanism of the ecosystem to meet the standards required of sustainable urban development. Attention is turned to two exemplary eco-city projects being implemented in China.

7.4.1 Dongtan Eco-city

Dongtan covers 8,400 ha and is a small Chongming Island north of Shanghai in the course of Yangtze River. The initiative came in 2005 when the Shanghai Municipal Government instructed its subsidiary "the Shanghai Industrial Investment Corporation" (SIIC) to invite the British consultancy firm, Arup, to design an energy-efficient eco-city. This model city, designed for 500,000 people, would use exclusively sustainable energy and save energy consumption by two-thirds compared to Shanghai. On the technological basis of sustainable development, Dongtan would be designed with the following features (Arup 2007):

- Solar panels, wind turbines and biomass-based fuels to generate energy;
- Buildings to have photovoltaic cell arrays on the roofs. The roofs will have gardens or other greenery to provide insulation and filter rainwater to help reduce energy consumption;
- Design will encourage use of public transport, cycling and walking within a compact city form: 75 dwellings per hectare, with a mixed low-rise and high-density of 3–6 storeys (about 1.2 average plot ratio);
- Distribution of gross floor area: 55% residential, 24% commercial, retail and light industrial, 16% culture, tourism, leisure and hotel, and 5% education and social infrastructure;
- Dongtan's refuse is to be recycled up to 80% (inclusive of organic waste such as rice husks which would be transformed to produce electricity and heat);

- Natural ventilation will be capitalized with adaptation to local microclimatic conditions; and
- Ultimately, the city should achieve an ecological footprint of 2.2 ha per person close to the standard of 1.9 ha per person set by the World Wide Fund for Nature (WWF), but only one-third of the current Shanghai city.

Scheduled to complete the first phase delivery by 2010, Dongtan's implementation nevertheless has been delayed. Critics have been suspicious of Dongtan's impact on the overall Chinese city system accommodating the majority of the urban population who are suffering from the polluting living environment. Some have even described it as a "Potemkin village" (a model unrepresentative of the urban development)!

7.4.2 Tianjin Eco-city Project

The project marks a landmark attempt that China has aimed to build an ecologically sustainable city in northern China known for its aridness in the face of frequent sandstorms from the Mongolian Plateau and Gobi Desert to its northwest.[2] Reportedly, a minimum of 30 billion yuan will be injected into this eco-friendly project situated on a 30 km^2 of coastal marshland, 150 km south-east of Beijing and 40 km from Tianjin. It is a new joint-venture between China and Singapore to build a prototype of "ecological civilization" targeted to achieve "energy-saving, mitigation of pollution and pleasant urban living".

Project management will be undertaken by the Sino-Singapore Tianjin Eco-City Investment and Development Company on a 50–50 basis, represented respectively by a Chinese consortium led by Tianjin TEDA Investment Holding Company and a Singapore group led by the Keppel Group (Quek 2008a, b, People's Net 2009). After the ground breaking ceremony held on 28 September 2008, the eco-city has taken off to construct its Phase 1 covering 4 km^2, and by 2020, it should accommodate 350,000 residents. Like Dongtan, the Tianjin Eco-city will use clean energy, public transport, waste recycling and large tracts of greenery to provide a socially harmonious living style (see Table 7.6).

Similarly, the conceptual framework deployed in Singapore in the early 2000s (integrating work, live and play) has been merged with the Chinese emphasis on harmonious and sustainable development as the planning rationale (Fig. 7.1). By projection, the eco-city will contribute towards the expansion of the Tianjin Municipal Region to become one of the four coastal megacities reaching beyond 10 million in China (see Tibbetts 2002). This gigantic joint project obviously carries certain significance for both Singapore and China.

7.4.3 Significance for Singapore

For Singapore, it matches its objective of regionalization drive and global integration in exporting management expertise and services driven as an economic motivating

Table 7.6 Characteristics of the proposed China-Singapore Tianjin Eco-city project

Item	Characteristics
Total planned area	30 km^2; Phase 1: 3 km^2
Population target	• 2010: 50,000 • 2015: 200,000 • 2020: 350,000
Implementation plan	• Phase 1 to start in June 2008; completed in 3 years • Whole project to be completed in 10–15 years
Targeted indicators	Control targets ensure: • Ecological & environmental health • Socially harmonious living & community growth • Recycling of economically valuable items (total 18) Guidance targets include regional coordinated use in: a. Clean energy b. Public transport capacity c. Water supply & drinking water systems d. Waste recycling e. Urban greenery f. Urban road system g. Community management system h. Culture, education and health research environment
Economic structure	Real estate, business, leisure & recreation, educational training, research & development, cultural innovative development, services outsourcing, modern service & high-end services
Mode of transport	Public transport-oriented concept focused on light rail system, supplemented by bus system, bicycle lanes & pedestrian walkways

Source: Compiled from various sources on Tianjin eco-city websites

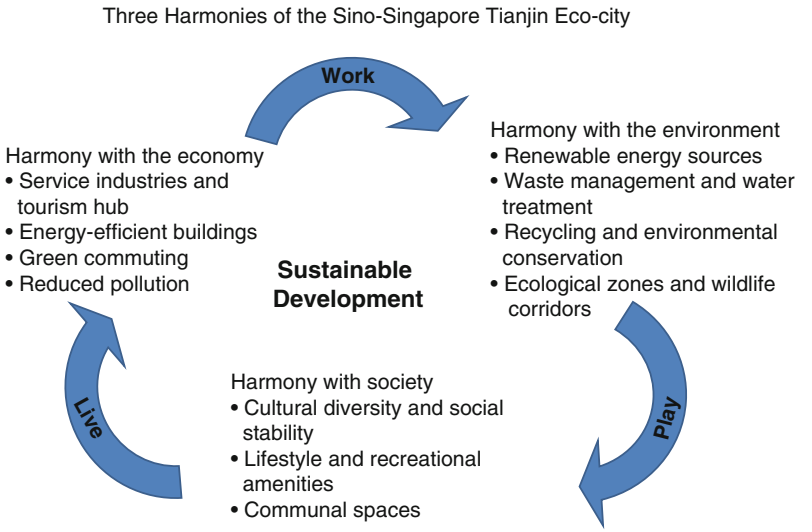

Fig. 7.1 The planning concept of Sino-Singapore Tianjin eco-city. *Source*: Keppel Corporation (2008)

force since the early 1990s. It is also a platform to practise "green and sustainable city" ventures in a large scale outside Singapore; such experience acquired would help the city-state to further its overseas businesses. Singapore agencies such as the Housing and Development Board, and the Building and Construction Authority have been working on affordable "green housing" for marketing with their Chinese counterparts (Oon 2009). Further, the project is symbolic of another grand urban planning and business joint venture after the "Suzhou Industrial Park" initiated in the mid-1990s. As always, the eco-city has turned out to be another revenue-generating opportunity.

7.4.4 Significance for China

China has taken the Tianjin project as an experiment with potential to improve urban liveability in a relatively fragile physical environment, especially in its north and western China. The Chinese government's emphasis on harmonious development means not only an important factor in socio-economic development which has seen today the need to narrow widening gaps between rich and poor, but also a common desire to achieve a sustainable physical environment in a rapidly urbanizing state. The venture has served as a lesson to growth-driven enterprises that eco-friendly, energy saving, and for the general public enhancement of civil awareness towards environmental protection, conservation are equally important as part of the development process. Clean environment with economic growth have become a new mandate of governance.

7.5 Discussion and Analysis

In Bossel's systems model of sustainability, as described in Newman and Jennings (2008: Chapter 5), it is highlighted that sustainable ecosystems have to be conditioned by healthy living, zero waste, self-regulating, resilience and self-renewing and flexibility. In meeting energy needs, Bossel's systems model stresses that this is accomplished through green plants, as autotrophs, acting as solar energy collectors. Sunlight is converted to plant biomass. Within an urban setting, eco-city environment facilitates autotrophic system to function in an extent where plants and animals can receive nutrients to live, grow and reproduce. Nutrients include carbon, oxygen, water, nitrogen, phosphorus and sulphur etc taken from the atmosphere itself, waterbodies, rocks and soils. Given that the biosphere is a closed system, nutrients are in fixed supply. Through the respiration processes, organisms produce wastes, and nutrients are cycled continuously between living organisms and air, water and soil in the form of biogeochemical cycles. The cycles produce nutrients and process wastes (see Newman and Jennings 2008: 95–112)

However, all ecosystems are situated within wider ecosystems which are interdependent up to the biosphere scale and covering vast areas or bioregions (ibid: 95).

Undisputably, the two Chinese eco-city projects discussed above have demonstrated a close matching in objectives and action plans but they are merely two nodal points in the sea of a large currently degraded urban environment. In terms of ecosystem coverage, they will have negligible or little impact as the central source of influence. On the contrary, they are vulnerable to adverse effects from the surrounding regions as pollutants do not recognize frontiers, whether national or international. Consequently, the road map for a better solution rests with the spacious urbanized hinterlands. In light of the global warming effects and the signal of melting icebergs in the polar zones, an eco-city's ability should include the adaptation to climate change. Coastal cities, in particular, have to be ready for changing sea-levels. Cities especially those in the tropical zones may experience an intensification of the urban heat island. It is timely now to examine how the green infrastructure is being developed and how the energy consumption of individual buildings is being reduced to mitigate such problems.

Building an eco-city is to build a human habitat towards a sustainable society. However, it is not merely about protecting and enhancing the physical environment. One has to look beyond the environmental aspect to include social and economic aspects of sustainability. In meeting social needs, the eco-city community needs to consolidate the following aspects:

(a) Making the eco-city settlement a "human" scale and form;
(b) Valuing and protecting diversity and local distinctiveness with local cultural identity;
(c) Protecting human health and amenity through safe, clean and pleasant environments;
(d) Ensuring access to quality food, water, housing and fuel at reasonable cost;
(e) Maximizing residents' access to skills and knowledge needed to participate an active social role; and
(f) Empowering the whole resident community to take part in communal decision-making activities including their workplace (see White 2002: 202).

Going beyond social sustainability, the eco-city would have to consider the promotion of economic viability in making the local economy vibrant without damaging the local and regional environment. The Eco-city idea nevertheless has been used hitherto by investors as a business venture at a commercially substantial scale involving a large and varied scope of economic activities whose merits and limitations are now discussed.

7.5.1 Eco-city: A New Form of Business Economics

Using latest ecological concepts, norms and technology to provide an artificial natural state of urban living environment (eco-city) is symbolic of a new knowledge economic sector, known as eco-nomics. Eco-nomics is also an advanced state of

capitalism in which green and clean technology is deployed to generate high returns to capital investment, serving at the same time the heatedly pursued environmentally sustainable objective.

The 1992 United Nations Conference on Environment and Development at Rio de Janeiro had affirmed that economic growth and environmental protection were compatible and that resources allocated to counter environmental degradation were justifiable by economic gains (UN 1992). In an international environment characterized by global competition, trade and heated pursuit to sustain high standards of consumption favouring economic growth, a world organization such as the UN had to opt for a material-based developmental stance, at odds with environmentalists who held different views (Clark 1995).

Well integrated into the globalized economic system, Singapore's interest in building eco-cities has become an international business venture. Singapore's expertise in water technology and energy has attracted collaboration from the United Arab Emirates to develop its Masdar City of 6.5 km^2, known as the Masdar Initiative which has an estimated US$22 billion ready for a comprehensive and ambitious undertaking. In developing and commercializing renewable energy technologies, this project has initiated a plan to boast a zero waste and zero carbon footprint. The city has been planned since 2006 by a British consulting firm "Forster and Partners" which designs to use 100% of renewable energies and house 1,500 businesses and 50,000 residents. Irrigation of vegetation and green areas will be solar-powered desalination plant and recycled water (Cheam 2009). Nevertheless, are eco-cities run as profit-oriented ventures free of weaknesses?

7.5.2 Weaknesses of Eco-nomics

Eco-nomics run as private undertakings in particular has limitations in achieving ideal sustainability. It tends to quantify costs and benefits accountable to stakeholders, corporate profits and competitive survival. By its very nature, it fails to see the full intrinsic values of living and non-living things and their interdependency on the Earth. Environmental sustainability, like esthetics, is not a yardstick of financial measurement, and is extremely difficult to quantify, especially in the long-term. Consequently, the operational basis of eco-nomics sees more clearly the profits than the costs that involve destruction of the environment. In our business-led contemplation of environmental protective measures, we may not take the best option of choices in decision-making.

In addressing the consequences of eco-nomics, Al Gore (2006:183–85) rightly points out that capitalistic undertakings do not predict nor are they willing to compute the environmental cost of development. From the same token, international organizations, such as World Bank, International Monetary Fund, regional development banks have unavoidably required recipients to justify their loans and monetary assistance based on economic performance. How in the development process the recipients' environment is destroyed is either beyond the control of the lending authorities or of secondary concern. The business functioning of eco-nomics is

unlikely to be successful, at least not in the short- and medium-term in "disempower[ing] the giant corporations immediately, just by not buying their products" (Register 2006: 221). It is difficult for us to imagine shrinking back:

> from the sprawled giants of today with their contradictory internal functions, becoming complex, integrally tuned three-dimensional structure, should produce complexities linked to one another so efficiently as to produce enormous prosperity relative to resources consumed. We may discover that the kind of prosperity of opportunity that enriches life the most is a prosperity of opportunity for untold enjoyment of time, creativity and nature (ibid).

Whether China's market-led eco-city development will meet the above cited challenge by according more priority to ecological benefits will remain to be seen. Although Dongtan's master plan is designed by Arup with ideal sustainability guidelines, critics have questioned the choice of using the Chongming Island, one of China's largest bird reserves for the eco-city project (DAC 2009).

7.6 Conclusion

Within the Earth's own operating system, national boundaries are no barrier to external encroachment of pollutants. Indeed, the scales and impact of ecosystems are so broad in range that they stretch from a local environment to that of the global. Within the complex networks of the global ecosystem, due to its dynamic interactions, a regional or national ecosystem cannot be studied in isolation from the other. Climate change is a case in point. A warmer world is seen as a crisis and a real threat to the common survival of living species (Newman and Jennings 2008: 92–93, White 2002). Much of this crisis associated with global carbon, hydrological and water cycles has a cause-effect with anthropogenic and human activities. Cities must be made part of the natural system, and fully integrated in the ecosystem.

Eco-cities are a response to the contemporary environmental and resource crisis arising mainly from human activities, and climate change. Cities where human groups are in their densest form with most acute problems are where remedial actions are urgently needed. Typically, catching up economically from behind, China's urban growth has witnessed an unprecedented pace accompanied by heavy pollution and environmental degradation since the 1980s. Three decades of Dengism has moved China from leftism to economic development without major turmoil, quadrupling the living standard and laying the foundation for ongoing systemic reforms. Dengism comprises pragmatism and gradualism in favour of material progress via a market-led economy with tight top-down administrative controls to ensure a peaceful transition. Accordingly, the formula that national leaders have to rely on economic growth to protect themselves against recession and inflation has to be compromised with less market-driven economic forces (see Clark 1995: 231).

This Chinese socio-economic transition with little political reforms with a strong emphasis on exponential growth pursuit is being questioned for its lack in

compatibility with environmental equilibrium. In technical terms, moreover, eco-city development being used as a business venture may create more wealth and capacity and technological resources to deal with the polluted environment and, in the process, generate more business opportunities in managing the degraded environment. But is this "nodal point effect" a viable treatment towards environmental sustainability and a more lasting ecological health in a vast and populous nation undergoing rapid and seemingly uncontrollable urban sprawl? Or, are eco-cities strategically used to produce a demonstration effect?

In dealing with its specific environmental pollution and degradation, China from a relatively low technological base and heavily GDP-led in approach, has interpreted the eco-city concept somewhat differently from the Western ideas of Newman, Register and White cited earlier in the chapter. In particular, as a late starter, China has to put in practical efforts to change many existing cities into an "eco-city". So long as some basic services are provided to enhance the ecological quality of a working environment, including mining towns, one can call it an eco-town. The peri-urban area of coal mining city of Huaibei in East China where measures of eco-service enhancement and ecosystem restoration have been experimented is one such eco-town. Over the last 50 years, this coal producing area has done much damage to the local surrounding farmland, and caused a high level of pollution and vast patches of subsiding terrain. In early 2009, an action plan was conceived aimed at restoring the original wetland conditions and preparing the eco-town towards a low carbon economy (see Wang et al. 2009). Another case in point is the effort dedicated to building Caofeidian into an eco-city in north China near Tangshan. Handicapped by lack of rainfall and fresh water and threatened by salt water, Caofeidian is to be constructed into an eco-city which is environmentally friendly, conservation-oriented, a high-tech oriented, yet a compact city meeting local norm of high-density living. Besides using wind energy as a key source of power supply, intensive water recycling will be heavily relied upon here, just like other areas in China where water is a scarce resource (Ma 2009, van Dijk 2010).

Having said these, if it is inevitable and necessary to build eco-cities as business operations and as a profit-led strategy, pursuing ecological sustainability objectives has to be more anthropocentric than considering the holistic intrinsic values of nature in the process. To be a green and vital economy may not necessarily rely on the logics of maximum profits and efficiency. Achieving a "compassionate relationship between society and nature", as Richard Register (2006: 214) would have desired, will need, in my view, a multi-pronged approach integrating ecological, social, economic, environmental and technological means. The question lies with where to strike a balance, and the extent set for priority for each. Despite their inherent weaknesses, the Dongtan and Sino-Singapore Tianjin Eco-city Projects are a step forward in building a more livable urban environment. With strong commitments from policy makers to implementers, and positive response from the corporate world and citizens, their demonstration effects will hopefully help create a strong inherent ecological consciousness and psychological base from which a wider spread of eco-friendly and environmental sustainable urban environment will be built.

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Notes

1. Common indices are those indicators considered to be relevant and suitable for all cities; characteristic indices consider the difficulties of success if certain criteria are used in some cities; and specific indices reflect the unique features of cities (Li et al. 2010).
2. There were four cities initially being considered: Tianjin, Caofeidian Industrial Park north of Tangshan, Baotou (Inner Mongolia and Urumqi (Xinjiang Province). Tianjin was seen as having the greatest economic potential that Singapore emphasized. For China, coastal Tianjin could be designed as a new growth engine in north China (Quek 2007: 2).

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